Consequence Analysis on the Transportation Accident of Spent Resin Waste From a Heavy Water-Cooled Reactor to the Gyeongju Disposal Facility

Ki Joon Kang[a], UkJae Lee, Jaeseong Min, and Hee Reyoung Kim

School of Mechanical, Aerospace and Nuclear Engineering, Ulsan National Institute of Science and Technology, Ulsan 44919, Republic of Korea

roffl1234@unist.ac.kr[a]

1. Introduction

The radiological safety is one of the important issues concerning accidents in transporting radioactive spent resin wastes from a heavy water-cooled reactor. Ion exchange resins are used to filter radionuclides in Wolsung nuclear power plant. The plant has storage with a capacity of (354.9 m^3). However, the amount of radioactive waste is expected to exceed it within 10 years. Therefore, the radioactive waste needs to be transferred from the Wolsung receiving area to the Gyeongju radioactive waste disposal facility. Once transported, 50 drums with a capacity of 200 L are carried on trucks, which is a large quantity, hence the radiation safety for accidents that may occur during transportation are essential. In this paper, the radiological safety assessment for the hypothetical accident is performed by evaluating the radiation effects after calculating the Total Effective Dose Equivalent (TEDE) using the HotSpot Code, which was developed by the Lawrence Livermore National Laboratory.

2. Materials and Methods

2.1 Input Parameters

The TEDE of cement solidification and dry spent resins are evaluated for radioactive waste. Cement solidification and dry spent resin are divided into 1% exposure and 10%. For the evaluation of atmospheric dispersion, 1% leakage is assumed to be a small value and 10% leakage is assumed to be a large value. Each case is divided into low-level waste (LLW) and intermediate-level waste (ILW) depending on whether it is lower than 10^{-3} Sv/yr. The HotSpot Code can set radioactive nuclides, meteorological and geological conditions, and can set the degree of radiation leakage (1%, 10%) and the duration of leak. The nuclides, which are ^{3}H, ^{14}C, ^{55}Fe, ^{58}Co, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{137}Cs, and ^{144}Ce are used according to the notification of the Nuclear Safety and Security Commission in Korea. The air condition is set to be very stable because it is most similar with the stable state since precipitation is high in July and the effect of atmospheric dispersion is the least, and wind direction and wind speed are set to NW and 4.7 m/s. The precipitation is set at 5.42mm, which is the average of precipitation in July of Gyeongju, accident site. Because July has a highest precipitation during the year. It is assumed that the radioactive waste would leak for 10 minutes in case of an accident. The location of the accident was set at an arbitrary midpoint on the path from the Wolsung receiving area to Gyeongju radioactive waste disposal facility in Google map. Gaussian plume model is used as diffusion model.

2.2 Total Effective Dose Equivalent

The TEDE contour plots according to distance is as follows. The doses of 1.0×10^{-11} Sv, 5.0×10^{-12} Sv, and 1.0×10^{-12} Sv shown in Fig. 1 indicate the dose when the leakage from the source to the atmosphere reaches the ellipse. The inner value 1.0×10^{-11} Sv is lower than 1.903×10^{-8} Sv, equivalent to 10 minutes effective dose of the annual effective dose.

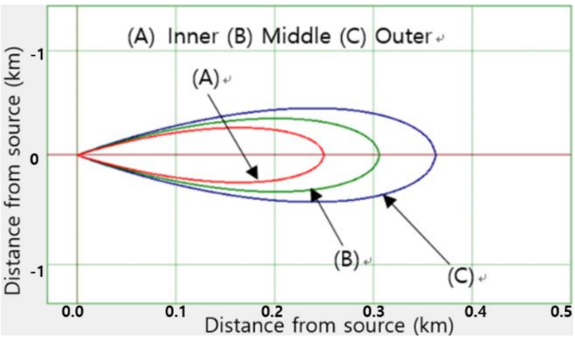

Fig. 1. TEDE contour plots of the cement solidification drum accident scenarios with 10% release of ILW (Inner: 1.0×10^{-11} Sv, Middle: 5.0×10^{-12} Sv, Outer: 1.0×10^{-12} Sv).

3. Conclusion

Among the eight cases, 10% leakage of the ILW dry spent resin showed the highest dose as 1.4×10^{-3} Sv during 10 minutes at a distance of 0.03 km from the hypothetical accident site. This dose is 140% of the annual effective dose of 10^{-3} Sv/yr. Therefore, additional measures are thought to need for radiological protection of nearby residents in case of radioactive waste transportation accidents.

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